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(54) **CONVECTION FURNACE**

(57) The present invention relates to a convection furnace for the heating of sheet metal. The convection furnace comprises a heating chamber, a fan, and a channel system arranged between the fan and the heating chamber. The fan is configured to draw air from the heating chamber and into the channel system. The channel system comprises at least one heating element and two channel sections extending into a top portion of the heating chamber. Each of the two channel sections comprises at least two arm sections extending alternately across the top portion from opposite sides of the top portion. Each arm section comprises a plurality of nozzles through which air is configured to be reintroduced into the heating chamber. With this arrangement, a fast and uniform heating of a sheet metal may be provided by the convection furnace.

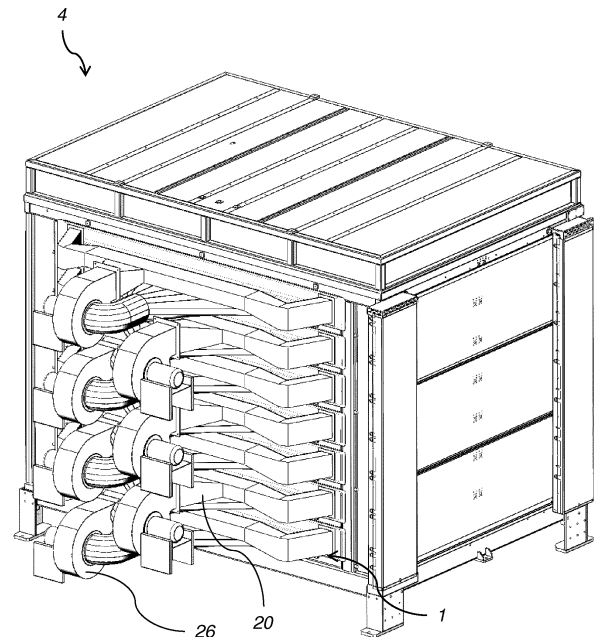


Fig. 5

Description

Technical Field

[0001] The present disclosure relates to a convection furnace, and especially to a convection furnace for heating of sheet metal.

Background

[0002] In sheet metal processing such as pressing, there is a need for heating the sheet metal before pressing. For heating the metal, convection furnaces may be used.

[0003] In these types of furnaces it is sometimes desirable to increase the heating speed of the sheet metal. A common way to achieve this is by a particular kind of convection furnace using forced convection in combination with radiation. A common way to circulate the air in a forced convection furnace is by use of a fan, such as described in US5660543A or US2676007.

[0004] A particular problem with these types of convection furnaces is the temperature non-uniformity in the heating chamber causing non-uniform heating of the metal sheet. Therefore, there is a need for a convection furnace which provides faster and more uniform heating of a sheet metal.

Summary

[0005] It is an object of the present invention to provide an improved solution that alleviates the mentioned drawbacks with present devices.

[0006] The invention is defined by the appended independent claims, with embodiments being set forth in the dependent claims, in the following description and in the attached drawings.

[0007] According to a first aspect, there is provided a convection furnace for heating of sheet metal comprising a heating chamber, a fan or a turbine, and a channel system arranged between the fan and the heating chamber. The fan or turbine is configured to draw air from the heating chamber and into the channel system. The channel system comprises at least one heating element and two channel sections extending into a top portion of the heating chamber. Each of the two channel sections comprises at least two arm sections extending alternately across the top portion from opposite sides of the top portion, and each arm section comprises a plurality of nozzles through which air is configured to be reintroduced into the heating chamber.

[0008] With this arrangement, the speed of the heating process may be increased. The air circulated by the fan is continually heated by the heating elements during circulation such that the temperature in the heating chamber may be kept uniform. The air may further be evenly distributed across the heating chamber through the nozzles. Hence, a fast and uniform heating of a sheet metal

may be provided by the convection furnace. The air drawn from the heating chamber by the fan may be reintroduced by the same fan through the nozzles via the channel system. The heating element in the channel system may compensate for heat losses due to the air transportation in the channel system. Each arm section may extend across substantially the entire width of the heating chamber. The channel sections may comprise an equal number of arm sections.

[0009] The present invention may further provide a convection furnace of compact height, enabling multiple convection furnaces to be arranged on top of each other in a useful way. A convection furnace according to the present invention may enable an embodiment of a convection furnace having a height of about 280 mm. Such compact height convection furnace is hence very useful for a multi-layer furnace application.

[0010] The arm sections extending alternately across the top portion from opposite sides of the top portion may mean that each channel section comprises two or more arm sections. A first arm section is part of a first channel section and may extend from a left side of the heating chamber. Next to this first arm section may a second arm section, being part of a second channel section, extend from the right side of the heating chamber. Next to the second arm section may a third arm section of the first channel section extend from the left, and next to this third arm section may a fourth arm section of the second channel section extend from the right. Of the channel section comprises additional arm sections, this alternating continues correspondingly. Hence, the first and third arm sections may distribute air from the first channel section, and the second and fourth arm sections may distribute air from the second channel section.

[0011] Each arm section may be formed as an air channel being open in one end, closed in an opposite end, and comprising nozzle openings in a direction towards the heating chamber.

[0012] In a further embodiment, the channel sections may extend from a backside of the heating chamber and wherein a first channel section extends along a first side of the heating chamber and the second channel section extends along a second side of the heating chamber, opposite to the first side.

[0013] The channel sections extending along opposite sides of the heating chamber allows for the air to be distributed with substantially even pressure across the heating chamber as equal amount of air enters the chamber from each side of the heating chamber. Each channel may extend along a side of the heating chamber, and extend into the arm sections. By extending along the sides the height of the convection furnace is kept low. The air may be drawn from the heating chamber by the fan at the back side of the heating chamber. The channel sections may then extend from the back side towards the sides of the heating chamber. The channel section may further extend along the sides of the heating chamber towards a front side of the heating chamber. The channel

sections may have a substantially rectangular cross-section.

[0014] In another embodiment, the heating element may be placed in the channel system after the fan and before the first arm section of each channel section respectively. The heating element may thereby recondition the air drawn out by the fan to desired temperature before re-entering the heating chamber. The heating speed of the sheet metal is thereby increased.

[0015] In another embodiment, the nozzles may be circularly shaped. The circular shape of the nozzles may provide a uniform distribution of the circulating air into the heating chamber, thereby providing a uniform heating of the sheet metal arranged below the nozzles.

[0016] In yet another embodiment, the diameter of the nozzles may be between 5-15 mm, preferably about 10 mm. The nozzles having a diameter of about 10 mm serves to minimize the difference between speed and pressure between the air entering the chamber through different nozzles and the pressure drop between the extracted air and the re-entering air. Alternatively, the speed of the fan may be adjusted to reach the desired speed and pressure of the air re-entering into the heating chamber.

[0017] In a further embodiment, a distance between a respective center of two adjacent nozzles may be between 40-120 mm, preferably between 80-120, more preferably about 100 mm. The distance between the nozzles further serves to minimize the pressure difference between the nozzles and the pressure drop between the extracted air and the re-entering air. It may further serve to provide a uniform heating of the sheet metal in the heating chamber.

[0018] In one embodiment, the nozzles may be arranged in a symmetrical pattern in order to get evenly distributed air across the heating chamber. The symmetrical pattern may be provided by a square shaped pattern or a honeycomb pattern or the like.

[0019] In another embodiment, the distance between the nozzles and a sheet metal to be heated may be between 50-100 mm, preferably between 50-80 mm, more preferably about 60 mm. The distance between the nozzles and a sheet metal to be heated in the heating chamber may be selected relative to the nozzle size and distance between the nozzles, in order to provide a fast and uniform heating as well as a compact convection furnace height.

[0020] In another embodiment, the fan may have a variable speed and may be configured to draw substantially the same amount of air out of the heating chamber that is reintroduced into the heating chamber through the nozzles. Maintaining the outgoing and incoming air in the chamber may assure fast and uniform heating of the metal sheet or blank. The air flow controlled by the fan may provide a substantially closed air flow system within the convection furnace, providing an energy efficient convection heating of a blank in the heating chamber.

[0021] In another embodiment, the heating element

may be an electrical heating element. The electrical heating element may heat the circulating air such that the temperature in the heating chamber is maintained.

[0022] In another embodiment, the heating element may be a gas heated element. The gas heated element may heat the circulating air such that the temperature in the heating chamber is maintained.

[0023] In one embodiment, each of the channel sections may taper along its extension along the sides of the heating chamber. The channel sections may extend along a respective side of the heating chamber towards a front side of the heating chamber. Along the extension of each channel section it may taper in the direction towards the front side. The tapering may be a decreasing cross-sectional area of the channel section. The tapering may provide a control of the air flow to all arm sections connected to the channel section such that a desired flow distribution is provided.

[0024] According to a second aspect of the invention, a multi-layer furnace comprising a plurality of convection furnaces as described above is provided. In a multi-layer furnace, a plurality of metal blanks or sheets can be heated simultaneously to speed up the heating process and the amount of sheets that can be heated simultaneously.

The convection furnaces may constitute convection furnace sections of the multi-layer furnace. Due to the arrangement of the convection furnace sections, each providing a convection furnace of compact height, the multi-layer furnace may comprise a plurality of convection furnace sections, for instance between 3-10 convection furnace sections, preferably between 4-8 convection furnace sections. In one preferred embodiment, the multi-layer furnace may comprise seven convection furnace sections. Using convection furnaces according to the present invention, which each may have a height of about 280 mm, a multi-layer furnace may be provided having seven individual convection furnaces with a total height of about 1960 mm. Hence, a very compact multi-layer furnace which still enable individual temperature control in each furnace layer may be provided.

[0025] According to a third aspect, there is provided a method for heating of sheet metal comprising. The method comprising the steps of drawing air from a heating chamber into a channel system, heating the air in the channel system by use of a heating element, transporting the air in the channel system into a top portion of the heating chamber via two channel sections, transporting the air in the channel sections alternately across the top portion from opposite sides of the top portion, and reintroducing the air in the heating chamber via nozzles in a plurality of channel arm sections extending alternately across the top portion of the heating chamber from opposite sides thereof.

[0026] By using this method, the heating speed of a metal sheet or blank can be increased as the air circulated by the fan is continually heated by the heating elements during circulation such that the temperature in the heating chamber is kept uniform as well as that the air is

evenly distributed across the heating chamber through the nozzles.

[0027] In a further embodiment, the step of drawing air from the heating chamber may be performed by a fan. The fan may draw the air from the heating chamber and further push the air through the channel system such that it re-enters the heating chamber. Providing warm air through the nozzles may speed up the heating process as it may reduce the effect of the heat reflected by the metal sheet to be heated.

Brief Description of the Drawings

[0028] This and other aspects of the present invention will now be described more in detail, with reference to the appended drawings showing a currently preferred embodiment of the invention.

Figure 1 shows a perspective view of a convection furnace according to an embodiment of the present invention.

Figure 2 shows a detailed view of nozzles in a channel system according to an embodiment of the present invention.

Figure 3 shows a cross sectional view of a convection furnace according to an embodiment of the present invention.

Figure 4 illustrates the flow of air through the convection furnace according to an embodiment of the present invention.

Figure 5 shows a multi-layer convection furnace according to an embodiment of the present invention.

Figure 6 shows the possible direction of movement when inserting blanks according to an embodiment of the present invention.

Detailed Description

[0029] The present invention will be described more fully hereinafter with reference to the accompanying drawings. In the drawings, like numbers refer to like elements.

[0030] A convection furnace 1 according to the invention is illustrated in fig. 1. The convection furnace comprises a channel system 2 extending from a backside of a heating chamber 3. The channel system 2 comprises two channel sections 21 a, 21 b, the first channel section 21 a extending along a first side of the heating chamber 3, perpendicular to the backside, and the second channel section 21 b extending along a second side opposite the first side of the heating chamber 3. The channel sections 21 comprise hollow arm sections 22a, 22b, extending into a top portion of the heating chamber 3. The arm

sections 22a, 22b extend alternately from the first and second side across the top portion of the heating chamber 3 towards the opposing first or second side. The channel section portion 20, at the backside of the heating chamber 3, comprises a fan 27, arranged in a fan housing 26, which recirculates the air in the heating chamber 3. The fan 27 draws the air out of the heating chamber and directs it to the channel sections 21 to be transported through the channel sections 21 into the arm sections 22a, 22b and from these re-entering the heating chamber 3 via nozzles 25 (see fig. 2). The airflow in the convection furnace 1 is illustrated by arrows in fig. 4. The speed of the fan 27 is adjusted such that a suitable air flow into the heating chamber 3 through the nozzles 25 is provided. The air extracted from the heating chamber is heated by heating elements (not shown) located between the fan 27 and before the extending portion. There may be a single heating element in a common part of the channel system, or two heating elements, one in each of the channel sections 21.

[0031] As illustrated in fig. 2, the side, first or second, from which the extending portion 22a, 22b is extending, comprises an opening 24 into the channel section 21 on the respective side such as to allow for air to circulate from the channel section 21 into the arm sections 22a, 22b. On the opposite side of the opening 24, the extending portion 22a, 22b comprises supporting means 23 resting on the channel sections 21 a, 21 b on the respective opposite side in relation to the side from which the extending portion 22a, 22b is extending. The arm sections 22a, 22b further comprise nozzles 25 through which air can enter into the heating chamber 21.

[0032] The nozzles 25 are placed on the heating chamber facing side of the extending portion 22a, 22b, such that the heated air can re-enter the heating chamber 3. The nozzles are evenly distributed in three rows on each extending portion 22a, 22b and have a diameter D being about 10 mm and a distance K between the central point of two adjacent nozzles 25 equal to about 100 mm. The distance and size of the nozzles is optimized to receive a uniform flow of air into the chamber and minimize the pressure difference between the nozzle 25 closest to the opening 24 and the nozzle 25 furthers away from the opening 24.

[0033] The channel sections 21 a, 21 b have a decreasing cross-section along the side of the heating chamber 3 towards an end of each channel section.

[0034] Figure 3 show a cross section of the channel sections 21 and the heating chamber 3. In the heating chamber refractory supports 31 support the blanks to be heated. The refractory supports 31 are aligned in parallel to each other and spaced apart with heating elements 32 placed in the space in-between. The combination of heating elements 32 and heated circulating air allows for faster heating and increased temperature uniformity.

[0035] A multi-layer furnace 4, comprising a plurality of convection furnaces 1 is illustrated in fig. 5. The convection furnaces 1 are stacked into a system where mul-

tiple blanks can be heated simultaneously in separate heating chambers 3. In the illustrated embodiment, seven convection furnaces 1 are stacked on top of each other to form the multi-layer furnace 4. The back of the multi-layer furnace 4 is seen in fig. 5. Each convection furnace 1 may be provided with an opening hatch on the front side (not shown) of the multi-layer furnace 4. As seen in fig. 5, the fan housing 26 and channel section portion 20 of each convection furnace 1 is arranged at the back of the multi-layer furnace 4. The features of the convection furnace 1 according to the present invention provide a low height convection furnace which enable a plurality of furnaces to be stacked in a multi-layer furnace.

[0036] When mounting the convection furnace 1 according to the invention, into an existing furnace, the channel system 2 may cause the convection furnace 1 to be wider than the opening into the furnace in which to be installed. In order to mount the convection furnace 1 in the existing furnace, the channel sections 21 a, 21 b can be pushed towards each other, as the arrows D1, D2 in figure 6 indicates, such that the distance between them is decreased. The supporting means 23 resting on the channel sections 21 a, 21 b are not fixed which allows the arm sections 22a, 22b to follow the movement of its respective channel section 21 a, 21 b in the direction D3, D4 as indicated in figure 6. When the convection furnace 1 has been installed in to the furnace, the channel sections 21 and arm sections are returned to the original position.

[0037] The channel system 2 including the arm sections 22a, 22b provides a compact height of the convection furnace, making it suitable for a multi-layer furnace. Further, the invention facilitates arrangement of such convection furnace in an existing non-convection furnace or multi-layer furnace.

[0038] Heating of a sheet metal using the described inventions is performed by drawing air from the heating chamber 3 through the fan 27 into the channel system 2. The air is further heated by the heating elements and transported through the channel sections 21, into the extending parts 22a, 22b and through the nozzles 25 into the heating chamber 3.

[0039] In the drawings and specification, there have been disclosed preferred embodiments and examples of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for the purpose of limitation, the scope of the invention being set forth in the following claims.

Claims

1. A convection furnace (1) for heating of sheet metal comprising
 - a heating chamber (3),
 - a fan (27), and
 - a channel system (2) arranged between the fan and the heating chamber,

wherein the fan is configured to draw air from the heating chamber and into the channel system, **characterized in that** the channel system comprises

at least one heating element for heating the air in the channel system, two channel sections (21) extending into a top portion of the heating chamber, wherein the two channel sections each comprises at least two arm sections (22), wherein the arm sections from the two channel sections extends alternately across the top portion from opposite sides of the top portion, and wherein each arm section comprises a plurality of nozzles (25) through which air is configured to be reintroduced into the heating chamber.

2. The convection furnace (1) according to claim 1, wherein the channel sections (21) extend from a backside of the heating chamber (3) and wherein a first channel section (21 a) extends along a first side of the heating chamber and the second channel section (21 b) extends along a second side of the heating chamber, opposite to the first side.
3. The convection furnace (1) according to claims 1 or 2, wherein the heating element is placed in the channel system (2) after the fan (27) and before the first arm section (22) of each channel section (21) respectively.
4. The convection furnace (1) according to any of the previous claims, wherein the nozzles (25) are circularly shaped.
5. The convection furnace (1) according to claim 4, wherein a diameter of the nozzles (25) is between 5-15 mm, preferably substantially equal to 10 mm.
6. The convection furnace (1) according to any claims 4 or 5, wherein a distance between a respective center of two adjacent nozzles (25) is between 40-120 mm, preferably substantially equal to 100 mm.
7. The convection furnace (1) according to any of the previous claims, wherein the nozzles (25) are arranged in a symmetrical pattern.
8. The convection furnace (1) according to any of the previous claims, wherein a distance between the nozzles (25) and a sheet metal to be heated is between 50-100 mm, preferably substantially equal to 60 mm.
9. The convection furnace (1) according to any of the previous claims, wherein the fan (27) has a variable speed and is configured to draw the same amount of air out of the heating chamber that is reintroduced into the heating chamber through the nozzles.

10. The convection furnace (1) according to any of the previous claims, wherein the heating element is an electrical heating element.
11. The convection furnace (1) according to any of the claims 1-9, wherein the heating element is a gas heated element. 5
12. The convection furnace (1) according to any of the claims 2-11, wherein each of the channel sections (21) tapers along their extension along the sides of the heating chamber (3). 10
13. A multi-layer furnace (4) comprising a plurality of convection furnaces (1) according to the claims 1-12. 15
14. Method for heating of sheet metal comprising the steps of: 20
- drawing air from a heating chamber (3) into a channel system (2),
- heating the air in the channel system by use of a heating element, 25
- transporting the air in the channel system into a top portion of the heating chamber via two channel sections (21),
- transporting the air in the channel sections alternately across the top portion from opposite sides of the top portion, and 30
- reintroducing the air in the heating chamber via nozzles (25) in a plurality of channel arm sections (22) extending alternately across the top portion of the heating chamber from opposite sides thereof. 35
15. Method according to claim 14 wherein the step of drawing air from the heating chamber (3) is performed by a fan (27) or a turbine. 40

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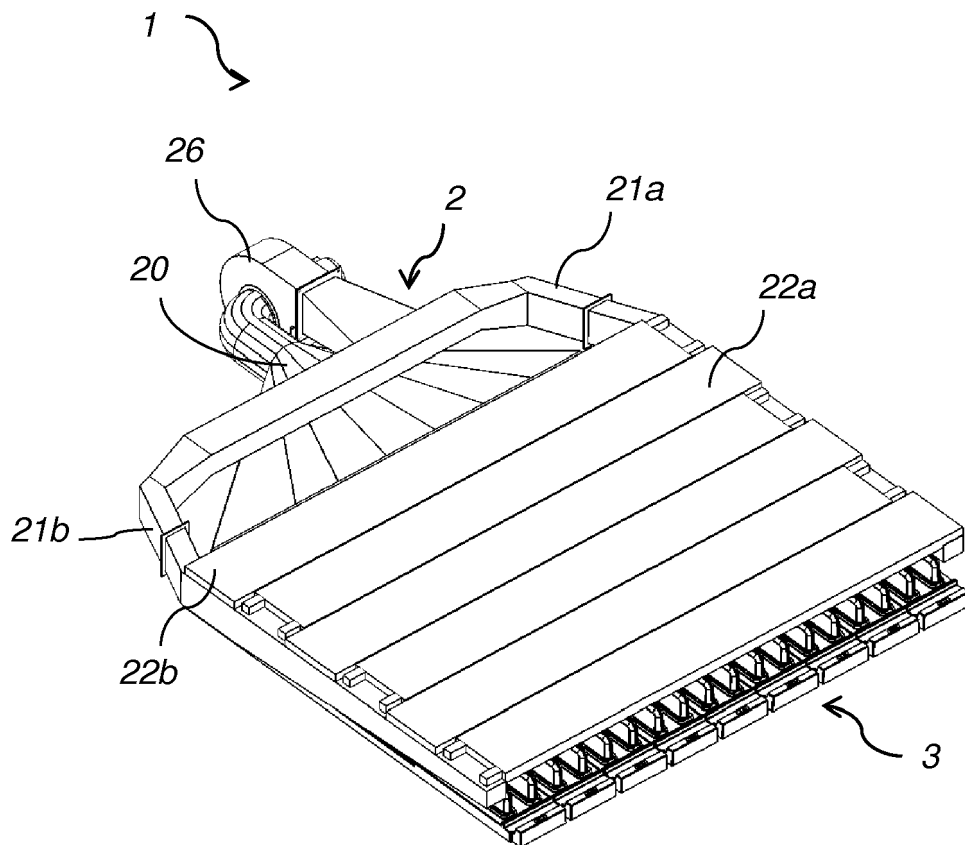


Fig. 1

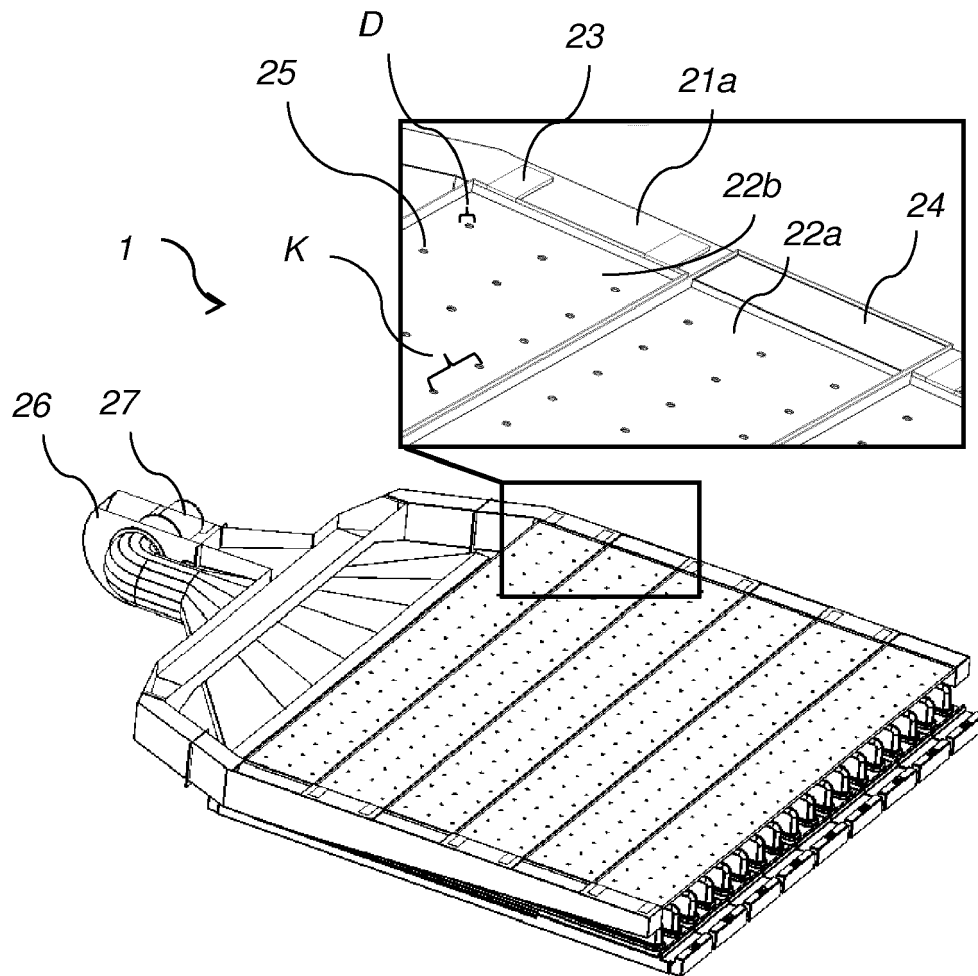


Fig. 2

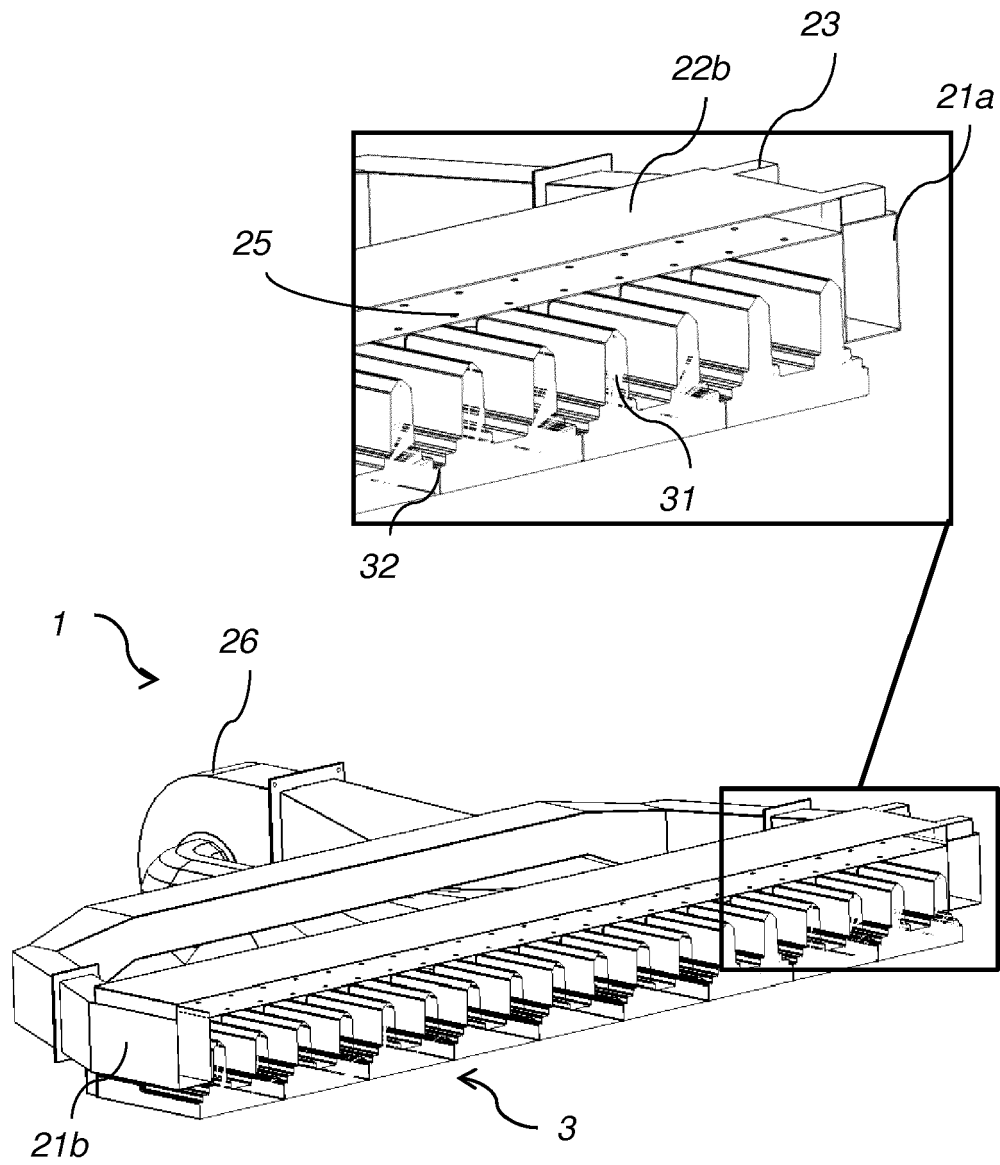


Fig. 3

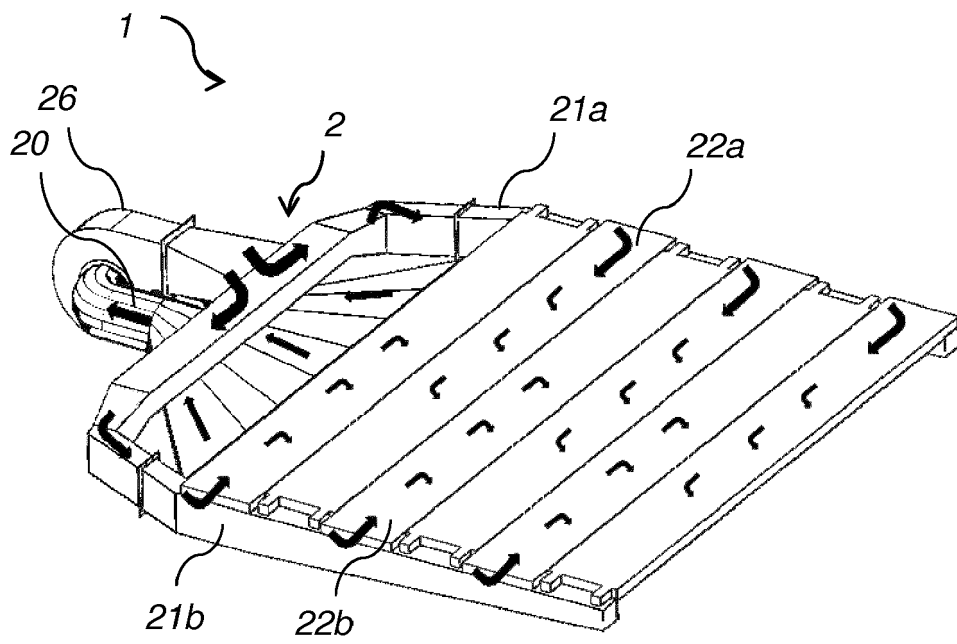


Fig. 4

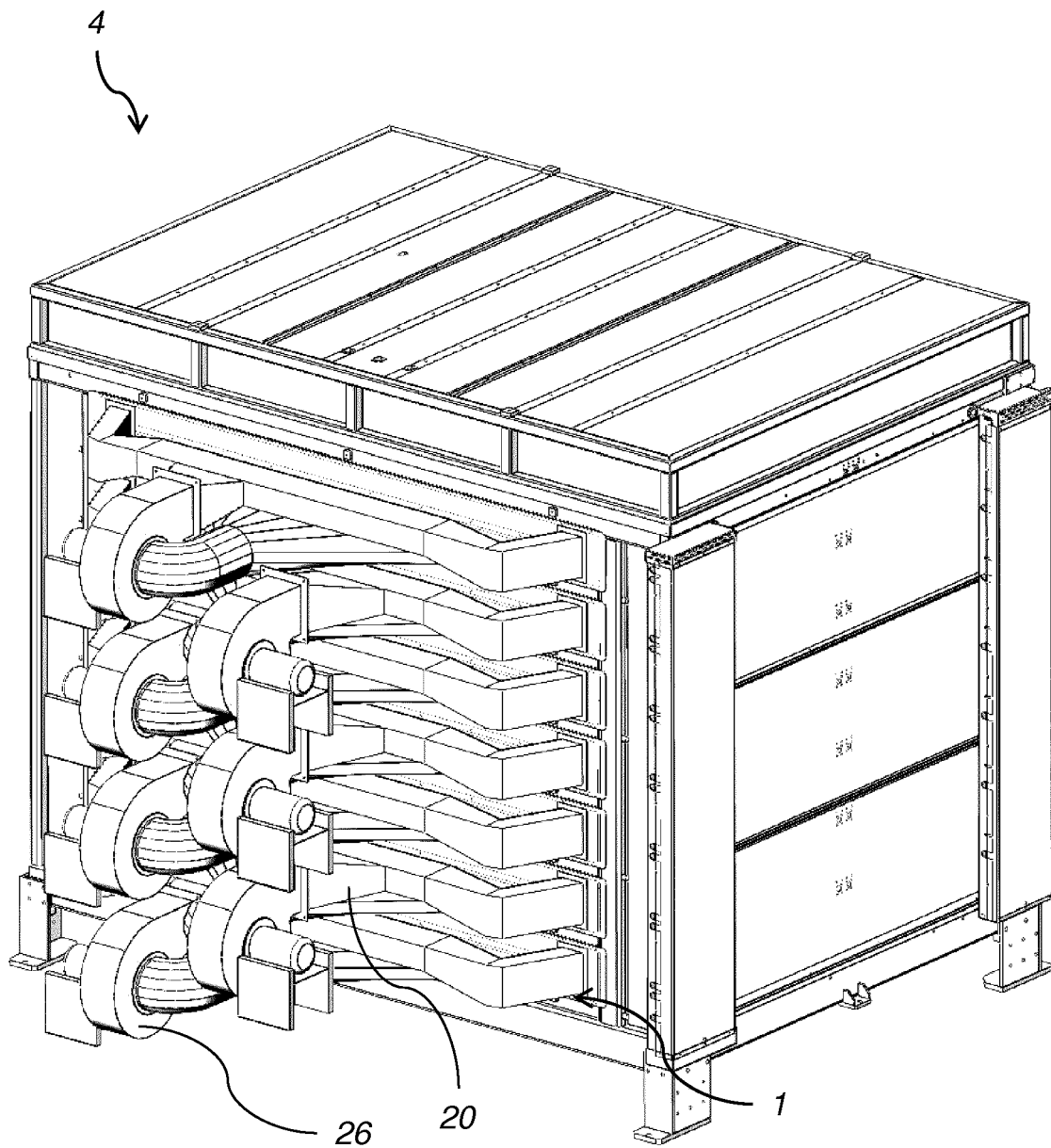


Fig. 5

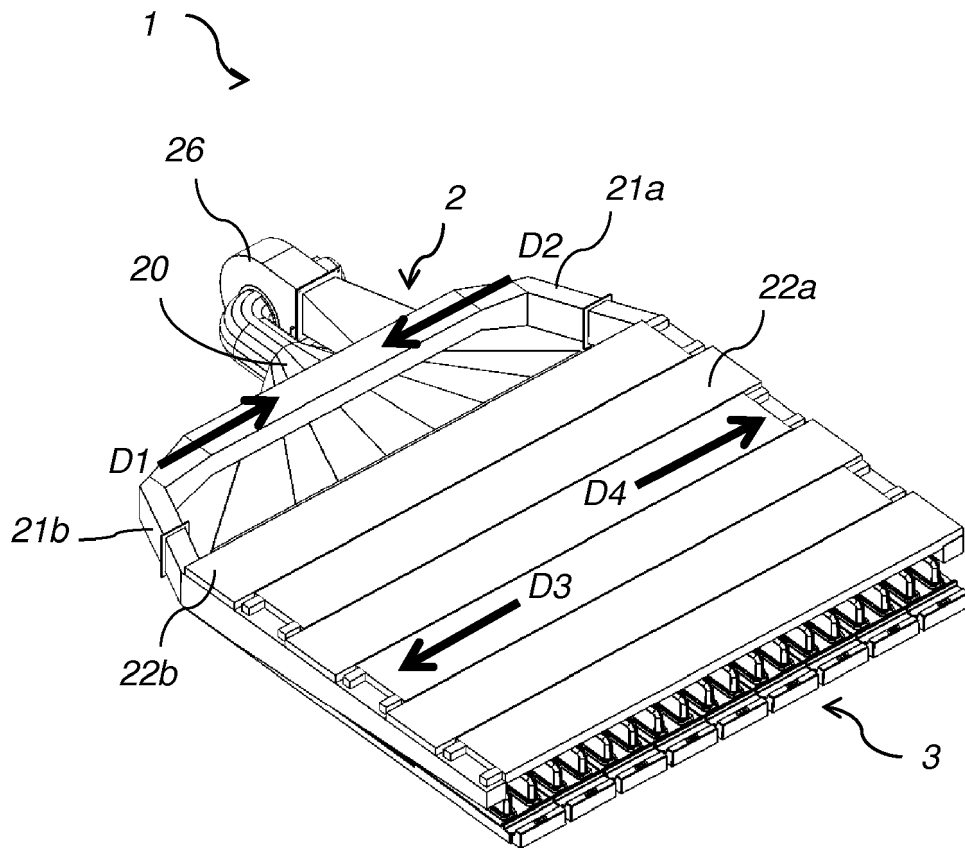


Fig. 6



EUROPEAN SEARCH REPORT

Application Number
EP 17 17 1435

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	CA 2 528 915 A1 (SCHWARTZ EVA [DE]) 24 May 2007 (2007-05-24) * figures 1, 2 * * page 1, line 5 - line 8 * * page 1, line 15 - line 30 * * page 3, line 9 - line 14 * * page 6, line 25 - page 7, line 26 * * claims 1-7 *	1-15	INV. F27B17/00 F27D7/04 C21D1/767
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A	US 5 660 543 A (MARKS THOMAS G [US] ET AL) 26 August 1997 (1997-08-26) * figures 1, 2 * * column 1, line 5 - line 15 * * column 3, line 7 - column 25 * * column 4, line 60 - column 6, line 55 *	1-15	TECHNICAL FIELDS SEARCHED (IPC) F27B C21D F27D
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 9 October 2017	Examiner Jung, Régis
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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